Widely distributed in northern United States and Canada. Distant reports it from Mexico (V. D.).

48. Elasmostethus cruciatus Say.

Rockaway Beach, VI (Bno.).—New York, North Carolina, Montreal, Utah and Vancouver Islands (V. D.).

BIBLIOGRAPHY.

N. B. 1. NATHAN BANKS. Addition to the List of New York Pentatonidæ. *Journ. of N. Y. Ent. Soc.*, 1903, 227.

N. B. 2. —— List of Insects taken on Ceanothus, *Ent. News*, 1912, p. 105.

H. G. B. H. G. BARBER. The Resurrection of *Thyanta calceata* Say from Synonymy. *Journ. of N. Y. Ent. Soc.*, Vol. XIX, June, 1911.

T. B. 1. J. R. DE LA TORRE BUENO. A Preliminary List of *Pentatomidæ* within 50 Miles of New York. Westchester Heteroptera I and II. *Journ. N. Y. Ent. Soc.*

T. B. 2. —— European *Heteroptera* supposed to occur in America. *Can. Ent.*, Nov., 1909, pp. 401–402.

T. B. 3. —— *Can. Ent.*, 1909, p. 134.

T. B. and E. J. R. DE LA TORRE BUENO and G. P. ENGELHARDT. Some *Heteroptera* from N. Carolina. *Can. Ent.*, 1910, pp. 147–151.

V. D. E. P. VAN DUZU. Annotated List of *Pentatomidæ* North of Mexico. *Trans. of Am. Ent. Soc.*, Vol. XXX.

V. D. 2. —— Notes on some *Hemiptera* taken in the Bermudas, by W. J. Palmer. *Can. Ent.*, 1909, p. 134.

G. K. G. W. KIRKALDY. Catalogue of *Hemiptera* (Heteroptera), Vol. I, *Cimicidæ*, 1909.

A. W. M. A. W. MORRILL. Description of a New Species of *Telenomus* (Hym.). *Amer. Nat.*, Vol. XL, 1, No. 487, pp. 417–430.

C. O. CHRIS E. OLSEN. Notes on Breeding *Hemiptera*. *Journ. N. Y. Ent. Soc.*, Vol. XVIII, 1910, pp. 39–42.

N. J. R. J. B. SMITH. List of Insects of New Jersey. *Annual Report of the N. J. State Museum*, 1909.

OBSERVATIONS ON THE LIFE HISTORY OF ENCHENOPA BINOTATA SAY.

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(WITH PLATES V AND VI.)

During the past few years I have been engaged in a systematic study of the *Membracidæ* and have prepared a number of enlarged

water-color drawings of both adult and nymphal forms. It is now my intention to make a careful study of the life histories of these insects, as opportunity offers, more especially of the local forms.[1] As a contribution towards this subject I present in this paper an account of the eggs, larvæ and nymphal forms of *Enchenopa* Am. & Serv. *binotata* Say.

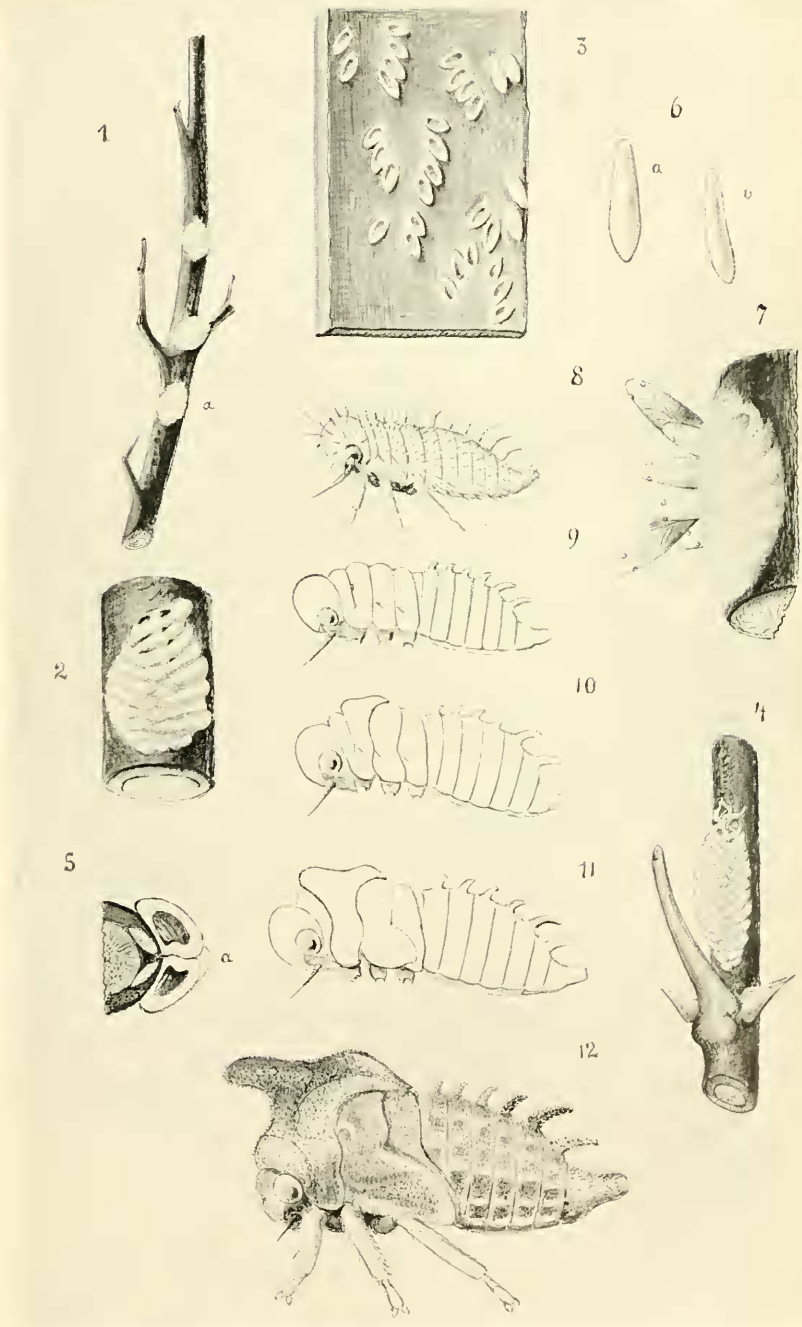
The nymphs of this form were the first known to me; and after repeated and painstaking search I have succeeded in finding their eggs and in rearing them. When I began, I had not seen the work of Dr. I. A. Lintner in his bibliography from 1882 in Ins. N. Y., 1st Rep't, pp. 281–288. Dr. E. B. Felt recently called my attention to it. In entomological works of later date I have found either no mention of the eggs of this species, or the statement that the eggs are laid in frothy masses on the twigs. This seemed strange to me, since I found that the insects have a rather strong ovipositor. Two years ago I examined a number of twigs richly covered with frothy masses, kindly sent me by Dr. B. E. Dahlgren, of the Field Museum, of Chicago, and by Mr. William Reiff, of Forest Hills, Mass., but a careful examination of this material failed to reveal any eggs.

Thinking that perhaps I had destroyed the eggs with the frothy substance, I tried to find fresh material myself. While searching in Central Park, New York, late in the autumn of 1909, I fortunately found two females at work on sheepberry (*Viburnum*); one had nearly finished forming the froth, the other had just begun. The latter was within my reach, so I broke off the twig carefully and took it home, together with the insect, and put it in a glass for closer observation. This change did not interfere with her activities, which indicates how absorbed these insects are in their work. The female produced the frothy substance in the form of a kind of foam, but eggs were not found in it. About three quarters of an hour is consumed in completing this work, sometimes perhaps longer, depending on the size and numbers of the layers. Fig. 1, Pl. —, shows the twig which I collected, somewhat enlarged, Fig. 1*a*, the mass that was partly produced in captivity, and Fig. 2, the same mass much magnified. The insect under observation died on the following day.

During 1910, from May 28 to July 4, Dr. Dahlgren sent me four

[1] I wish to express my thanks to Professor Wm. M. Wheeler and Dr. E. B. Southwick for kindly giving me much valuable advice in these studies.

different lots of perfectly fresh twigs of *Ptelea trifoliata*. He says in his notes: "The branch with the *Enchenopa* which I sent you is of the hop-tree (*Ptelea trifoliata*). The insects have, during the past two summers, been quite numerous in Jackson Park, Chicago, but I have not found them on any other shrub or tree." In the first lot received, I could find no eggs for some reason, the frothy masses appearing to have deteriorated. They were dirty, dry and brittle, but under the microscope showed numerous nymphs, which, as I stated later, were in the first stage. They were so small (between 1–1.3 mm.) that I was unable to see them with the unaided eye. I was not sure whether they really came from the supposed egg-masses in the above-mentioned condition. I then split one of the twigs, and taking off the bark, found on its inner side the empty egg-shells, with a few entire eggs. This proved that what I had erroneously taken for egg-masses were merely masses of a substance heaped over slits on the bark, somewhat in form of egg clusters, for a protective purpose. The eggs are really laid in two rather parallel slits which are made in the bark, side by side, in more or less obliquely arranged rows, as shown in Fig. 3, which represents the inner side of the bark. The frothy masses, if protected from wind and weather, however, seem to persist for some time, as I have observed in specimens of twigs kept in my collection for the past four years. I found considerable variations in the insects, taken from different plants, not only in the color of the nymphs, but also in the form of the egg-mass, number of eggs, and in the forms of the protecting masses. On *Viburnum* and *Robinia* the egg-groups are more numerous and always laid in one direction, as they rest mostly with the head directed upward and outward, in crowded conditions, as shown in the bark of *Ptelea* in Fig. 3, where one of the groups had been placed in the opposite position. But this does not seem to be the case where the insects occur in smaller numbers, since it has not been found on both the plants observed by myself. On *Viburnum* I found that they often prefer to begin on the forkings of the twigs; on *Robinia* above the bases of the leaves or thorns as shown in Fig. 4. In 10 specimens of covered egg-groups on *Viburnum,* I found the number of eggs in a group ranging from 9 to 17; on *Robinia,* by inspecting 4 specimens, from 11 to 16, placed rather irregularly in the slits, as one of them contained 10, the other of the same group only 4 eggs. On the thicker twigs of *Viburnum* the



Enchenopa binotata.

rows often run together in a horseshoe-like formation and one or the other egg is placed to one side of the row, especially inside, and sometimes filling the space between them. On *Robinia* the rows are straighter, in *Cicada* fashion. In covering the eggs with the frothy mass the insect always starts below the slits, for which purpose she lifts her abdomen and by moving the ovipositor down and up transfers the substance to the tip, from which it is directed to the desired place by moving the whole body. In the beginning the layers are very short but soon they become longer, as the height increases, and assume more or less the shape of a string, to become about half way beyond of the approximate height of 4 mm., then shorter again, so as to form more or less of a rounded shape on *Viburnum;* and more oval on *Robinia;* on the latter plant they become only half as broad as on the former. Mostly those layers appear somewhat slanting down from both sides to the center, where the insect usually stops and connects the half built layer with the bark of the twig. From this point on the outer end of the layer becomes connected with the bark by means of a thinner string. And they build these masses, sometimes half as high, sometimes fully as high from the twig, as they are broad, leaving on each side a hollow space as seen in Fig. 3, which shows the inside structure about the middle of its length strongly magnified. At that place in the center the more or less frame-shaped layers meet and are often connected with a short separate layer (Fig 3*a*). On *Viburnum* the work appears sometimes coarser than on *Robinia,* where the insect needs some 15 layers. On *Viburnum* I sometimes counted only 9, in which case I found the layers mostly very loose in the upper portions, with holes through which the bark of the twig could be seen. They generally end with the small layers irregular.

The beginning of oviposition I observed on *Viburnum* in Roselle, N. J., on August 6, where the first three specimens of egg-coverings were found, of which one only was half finished. I tried to bring the insect home in a glass, but it had been thrown off by a leaf, and in captivity did not finish. It died after five days. I noticed that if the insect was violently removed, it would not return, as I found one half-finished covering on the bush, without any female nearby. About a week later a new mass was built on to it. The first mentioned half-finished covering gave me an opportunity to study its inner structure, as above described. On *Robinia* in Nahant, Mass., this

season, I found the first insects in the act of egg-covering on August 15. They always worked on the under side of the branch, and on the south side of the bush, as they do on *Viburnum.*

The oviposition of *Enchenopa binotata* lasts until October, when the frosts kill them. During that month I found the insects less lively and in one case, on October 8, I found one insect on the same spot and in the same position as the preceding week. Thinking it was dead, I took it down, but while holding it in my hand for a little while, it revived and leaped away before I got the bottle ready for collecting it.

How many of the covered egg-groups are produced by one female I have not been able to make out, but there are a number. Of the insects I collected at work on August 6, I found one containing 6, the other 10. In the insect with the half-finished covering there were 5 more eggs. On September 3, one insect collected purposely for inspection still had 19, another on October 1, 7 eggs, and one collected on October 8, which died on the 14th, had still 24 eggs, of which 4 were found in the thorax and 20 in the abdomen.

The autumn eggs differ from those eggs found in spring (Fig. 6*a*), being thinner, a little curved, as shown in Fig. 6*b*. According to the statement of Dr. Lintner (p. 286), concerning the eggs of *Enchenopa binotata* on *Celastrus,* inspected by Dr. Hagen, they must vary considerably in size and color, for his measurements are different from mine on *Ptelea, Viburnum* and *Robinia,* where I found them about 1–1.3 mm. in length, and of a more or less milky, glassy appearance. Mr. Sidney I. Kornhauser recently favored me with a letter, in regard to his observations on that species, in which he says: "The frothy mass is secreted from a pair of big sacs at the end of the oviduct. These sacs have glands attached, and contain a very sticky substance. Both cuts are then covered by this white froth. The eggs are first soft and often much out of shape, but later they become more rounded and force the crack in the stem open." Oviposition lasted from August 6, during the month of September, until October. Most work had been done in the first part of September; from that time on I could not find the coverings increasing much in number. Of course, the observed bushes had been frequented only by a small number of insects and so I found colonies of the egg coverings very small. The best covered twig showed on October 15 only 11 specimens; the

number of insects I found on October 15 was greatly reduced from those of October 8, on which 6 specimens had been found; on the 15th there were only 3. The insects, although it was the middle of the day, seemed to be very weak since when I touched one, it hardly moved; another I saw somewhat higher on the limb, just beginning to move, at the same time a slight breeze sprang up, the insect fell to the ground and being much of the soil color, I was unable to find it.

While hunting for eggs of these species in the spring on the above-mentioned bushes on *Viburnum* I found markings on the twigs of egg-covering, which seemed to be of the previous season. The slits were partly open, somewhat exposing the eggs. On May 7, I took one of the twigs home, hoping to be able to observe some of the developing nymphs. For that purpose I kept the twig in water, but as it began to wither, I started out on May 14 at 6 o'clock in the morning in order to get another fresh twig. I found on several of the egg-areas some yellow objects moving, but owing to their small size was unable to make out their nature. But with the magnifying glass at home I saw that they were the larvæ making their escape from the eggs and at one spot as shown strongly magnified in Fig. 7, they came out six at a time. Two had partly emerged, the rest were just commencing. By watching the spot carefully I found the last one ready to emerge at 9 o'clock. Then looking over the twig first collected, I found a number of developed nymphs.

The larvæ are of a light yellow, with crimson eyes, and somewhat more orange-red markings on the abdomen, covering laterally, three segments from its base. In the larvæ this color runs together, nearly forming a ring, but in the nymph stages, where the abdomen extends, and also in the adult stage, it forms two lateral red markings. The larvæ on first emerging are smooth, but when they come about half way out, they commence to build up the first stage of the nymph. The head first assumes its form, and the hairs on it, that had been smooth, stiffen out, as do also the body-rings one after another. The legs become free, and then the abdomen takes on its shape, the latter having in that stage the prominences very short with long hairs. All the hairs are rather long in this stage, curved and directed backwards. Then the insect gets a hold on the twig and, freeing itself entirely from the egg, after a short rest, walks up to the leaves, probably to feed near the base on the petiole. This seems to be their

favorite place, as it offers more protection at first, being of the same yellow-red as the nymphs. The nymphs rest in one place most of the time; before shedding they become very restless and look for a suitable place. In the first stage, especially, I noticed that they preferred the under side of the leaves. They seem not to like to be exposed to light during ecdysis. I had been watching one ready to shed, and it moved out of the sunlight, at the last minute, where I had put it to see the breaking open of the thoracic integument. A little later the insect was already partly out. During the process the nymph stretches the whole body, and owing to this extension, the skin breaks open on the upper part of the head and thorax; the insect then pulls out the head first, then the thorax with the legs, and finally the abdomen, usually resting for a little while on the empty shed skin, before leaving it. This process takes place in the morning hours. I seldom observed it later. The insect puts its piercing mouthparts into the plant at once, as I usually found the empty, shed skin fastened beside the legs. It is characterized by changes in all the larval colors. In the later stages, the fore parts, the abdominal prominences and anal region are whitish at first, the abdomen more or less greenish the lateral red markings somewhat restricted. In the adult stage, before changing into the more or less dark brown color, these lateral markings occupy only the second of three segments fully, on the first and third only half the width of the segments. The whitish yellow on the fore parts becomes after the second stage, as I noticed in the nymph before shedding, more or less of a pinkish red; likewise the abdominal prominences and anal region, but these always soon change to the darker color after shedding. In the first stage, after about two hours they become a very glassy gray. Then, by the night of the same day, they become brownish-gray above. Ventrally the abdomen remains green, the mouthparts, pectus and femora of a dark, almost black, shining brown; except in the last nymph stage, when it become a somewhat lighter red-brown.

In the brownish gray stage the material from Chicago was received. What I missed then, I found during the second day in the insects under observation this season; they appeared dorsally with a whitish covering of an apparently porous nature. I found this also (although slightly) on the brown-gray colored nymphs from Central Park, New York. As I collected mostly all the material in the later

stages, I found the covering always very slight, only feebly developed on the head and margins of the body. On the nymphs collected from oak and walnut I have not seen any such covering. This covering is only on the dorsal portions, and very little of it on the legs (the apex of the femora and upper parts of the tibiæ). The porous covering shows best in the empty shed skins of the first two stages; it is then of a very brilliant white. It diminishes in every following stage and there is none in the adult. I found the covering in the adult on the head and prothorax only on one southern species from Brazil (*Sphongosphorus*). This was of a yellow color.

The color of the nymphs I had previously seen was always more or less brown-gray, but they vary in color on the different plants, and even on one and the same plant. The front parts become more or less brown from pink, and sometimes on and above the head a little greenish; the abdomen laterally more or less red-brown. This color starts from the red markings, and gradually occupies the ventrolateral parts and becomes somewhat darker and fades into greenish on the dorsal region. Then in the later stages the insects acquire five lateral rows of grayish-white markings. The abdominal prominences and anal region are more reddish-brown, the fourth and fifth pair of the former being in the last two nymph stages very dark. The hairs which are long in the first stage, become short in the following stages, but greatly increase in number, especially on the abdominal prominences. The lateral white markings were found on the dark-colored nymphs from Central Park, but more yellowish and only slightly indicated. On the material collected at Newark, N. J., on oak and walnut last year, there was none of the lateral white markings; and the coloration was quite different from all the nymphs I had seen before, so that at first I was inclined to believe I had taken another species. The specimens were of a beautiful green color, on the fore parts (prothorax and wing-pads) red, shading very slightly into brown; the basal portions of the legs, the pectus and mouthparts were brown; the tibiæ and abdominal prominences yellowish, suffused with rose-red; the anal region and the venter darker passing into brown. The first nymphs of this description were found July 26, on oak. July 1, the same form, only somewhat larger, was taken on walnut. July 6, I could find no more specimens on oak but in addition to adult insects (three males and one female) there were two nymphs. The